



US009122127B2

(12) **United States Patent**  
**Shodai et al.**

(10) **Patent No.:** **US 9,122,127 B2**  
(45) **Date of Patent:** **Sep. 1, 2015**

(54) **LENS HOOD AND IMAGING APPARATUS**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/527,503**

(22) Filed: **Oct. 29, 2014**

(65) **Prior Publication Data**

US 2015/0131985 A1 May 14, 2015

(30) **Foreign Application Priority Data**

Nov. 8, 2013 (JP) ..... 2013-231879  
Jul. 14, 2014 (JP) ..... 2014-143819

(51) **Int. Cl.**  
**G03B 11/04** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **G03B 11/045** (2013.01)

(58) **Field of Classification Search**

CPC ..... G03B 11/045; G03B 11/043; G02B 23/16  
See application file for complete search history.

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(57) **ABSTRACT**

A lens hood which is integrated with a lens cover is provided. The lens hood is attached in front of an imaging lens, and is configured to prevent undesired light incident on the imaging lens. The lens hood includes a lens cover having an upper door and a lower door, and a hood body. The hood body supports the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, and has a storage space that stores the upper door and the lower door.

**18 Claims, 12 Drawing Sheets**

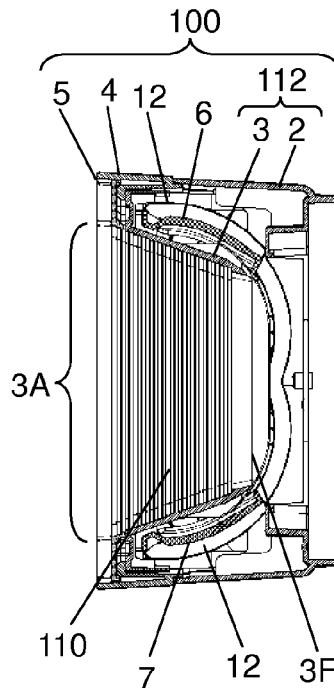
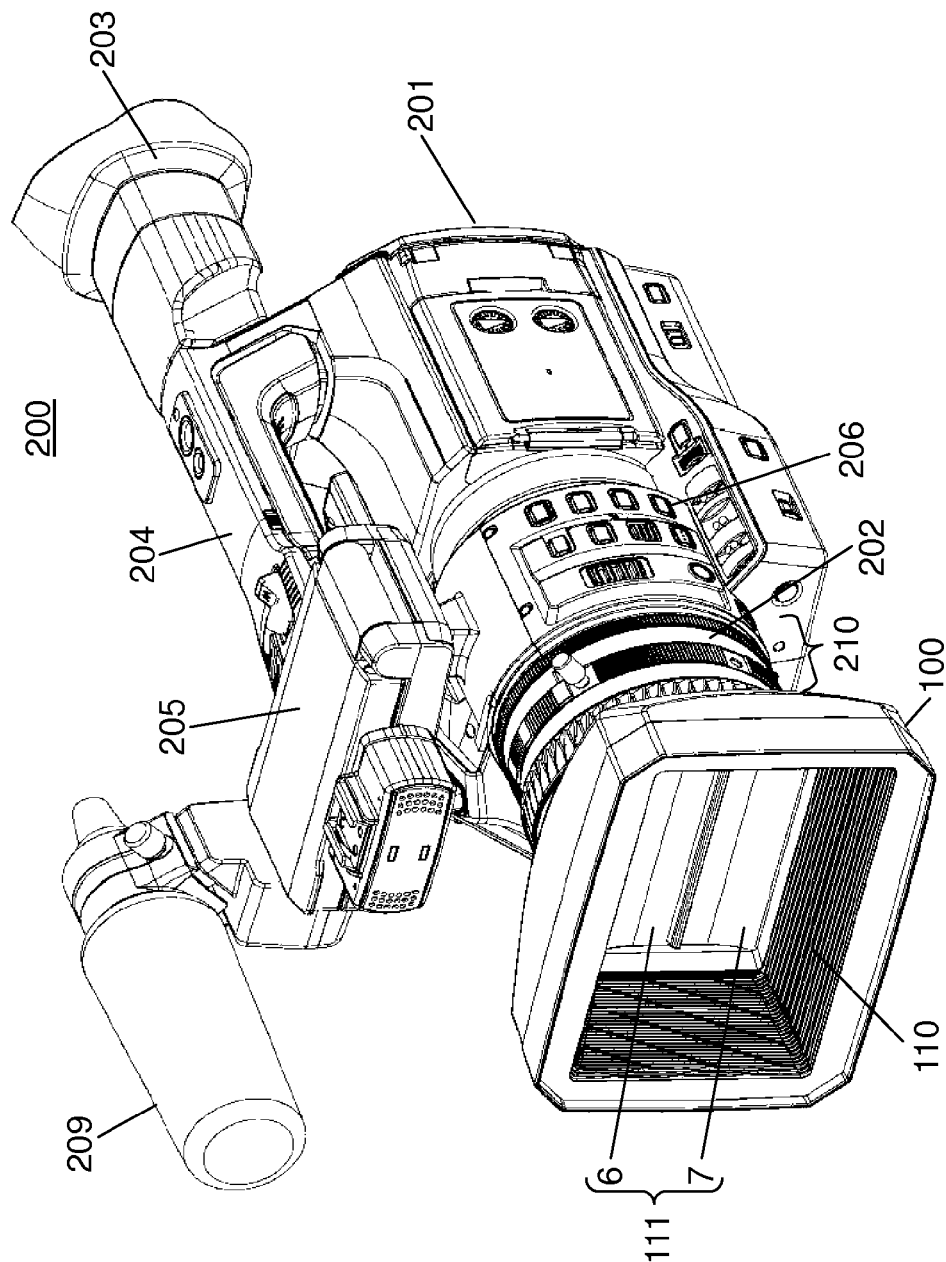


FIG. 1A



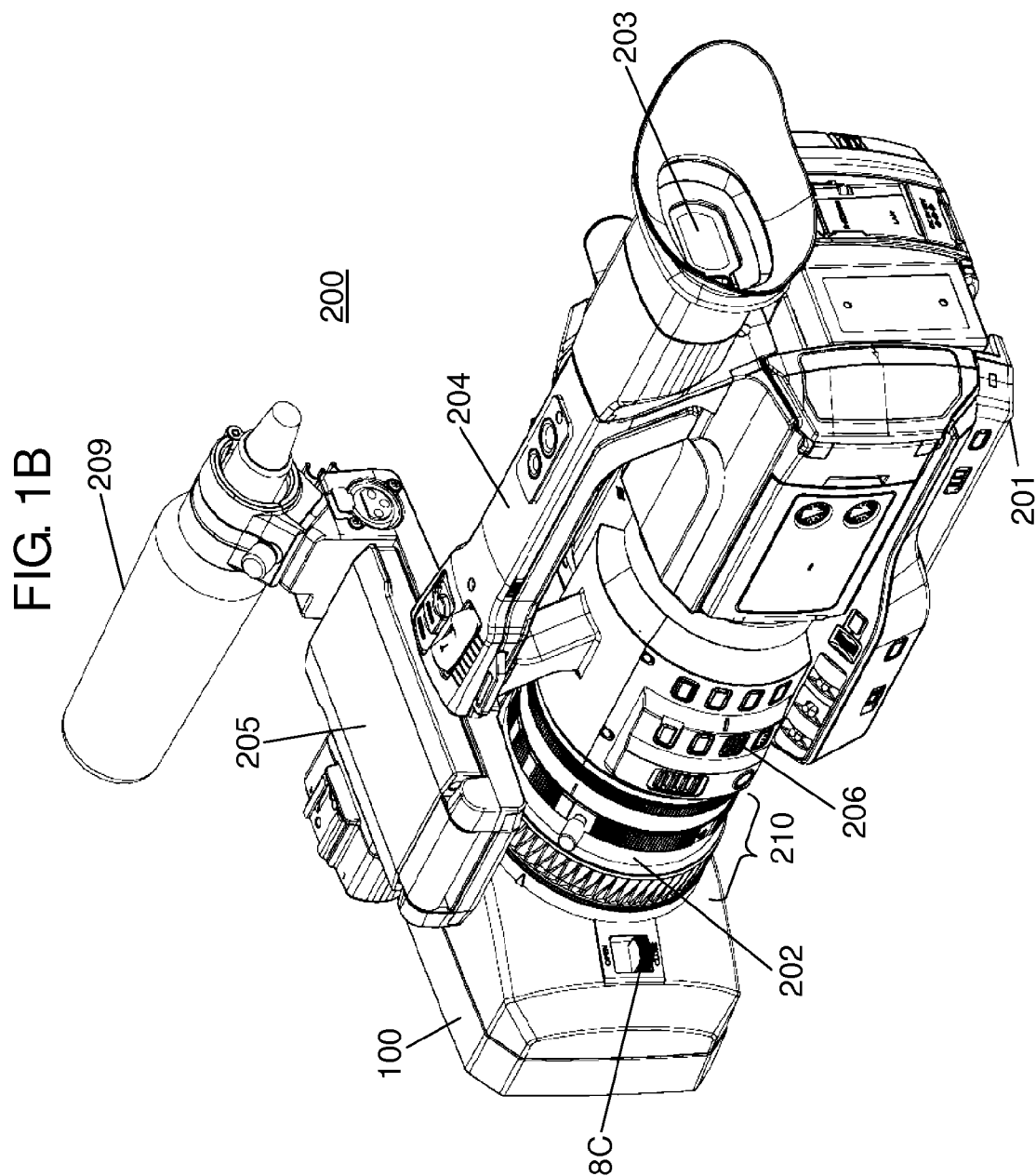


FIG. 1C

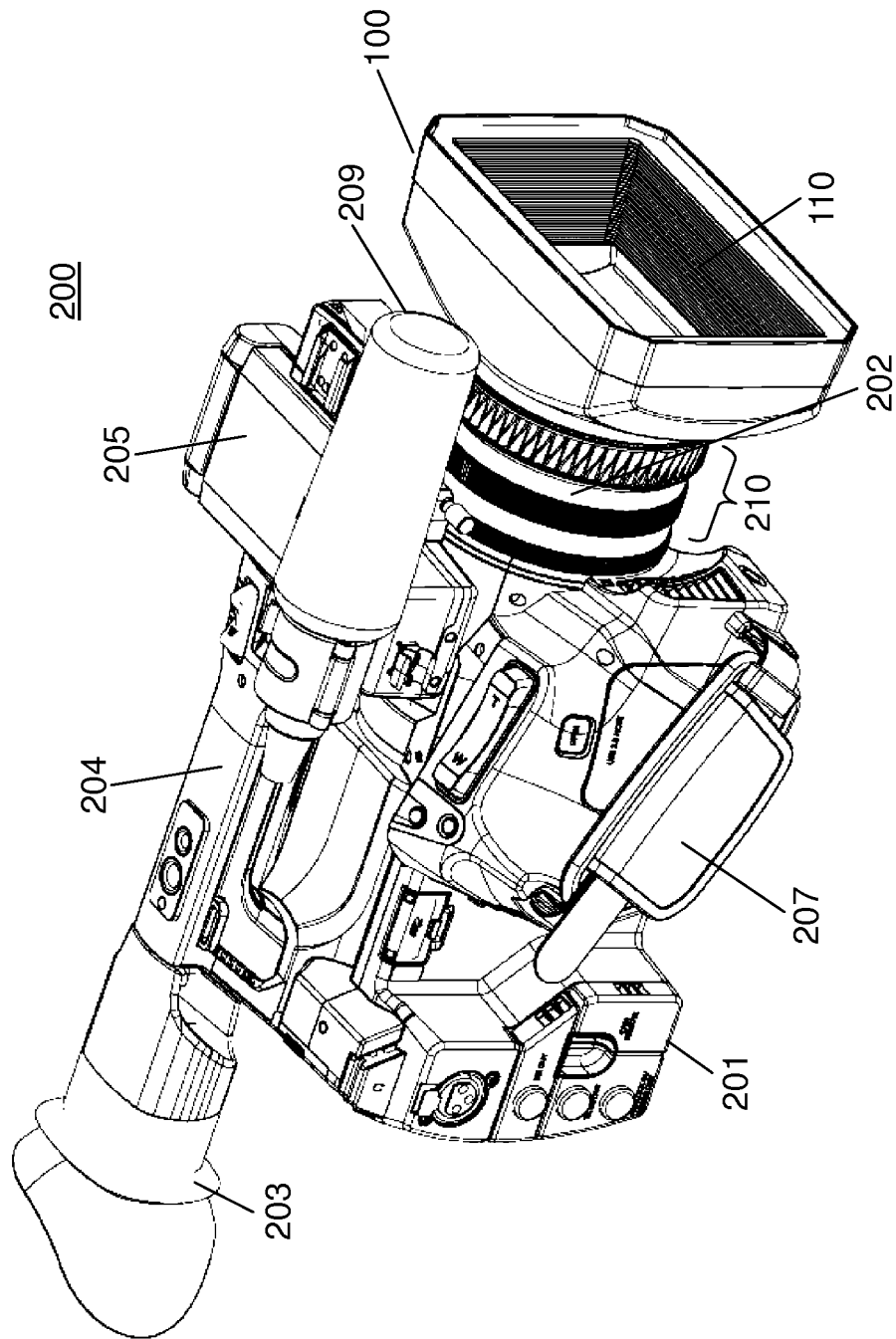


FIG. 2A

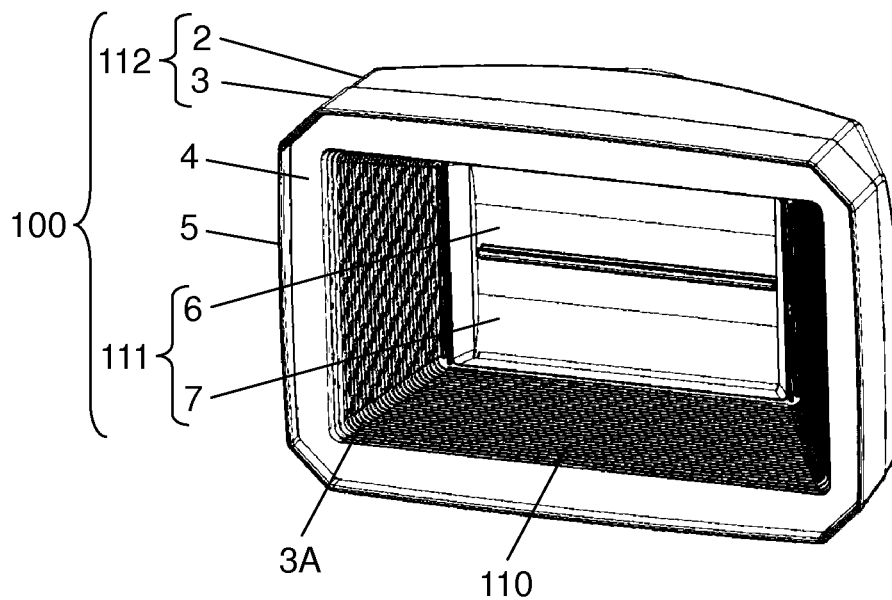


FIG. 2B

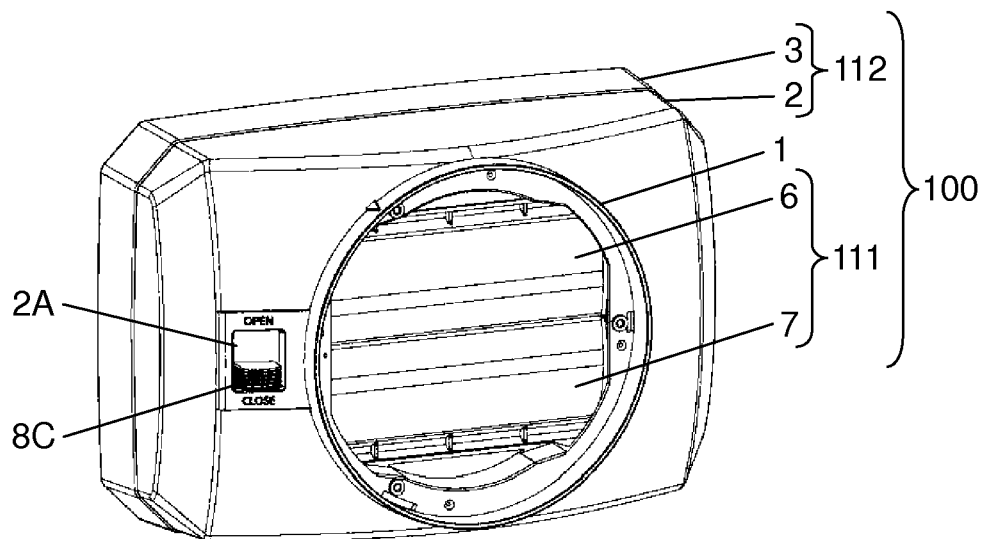


FIG. 3

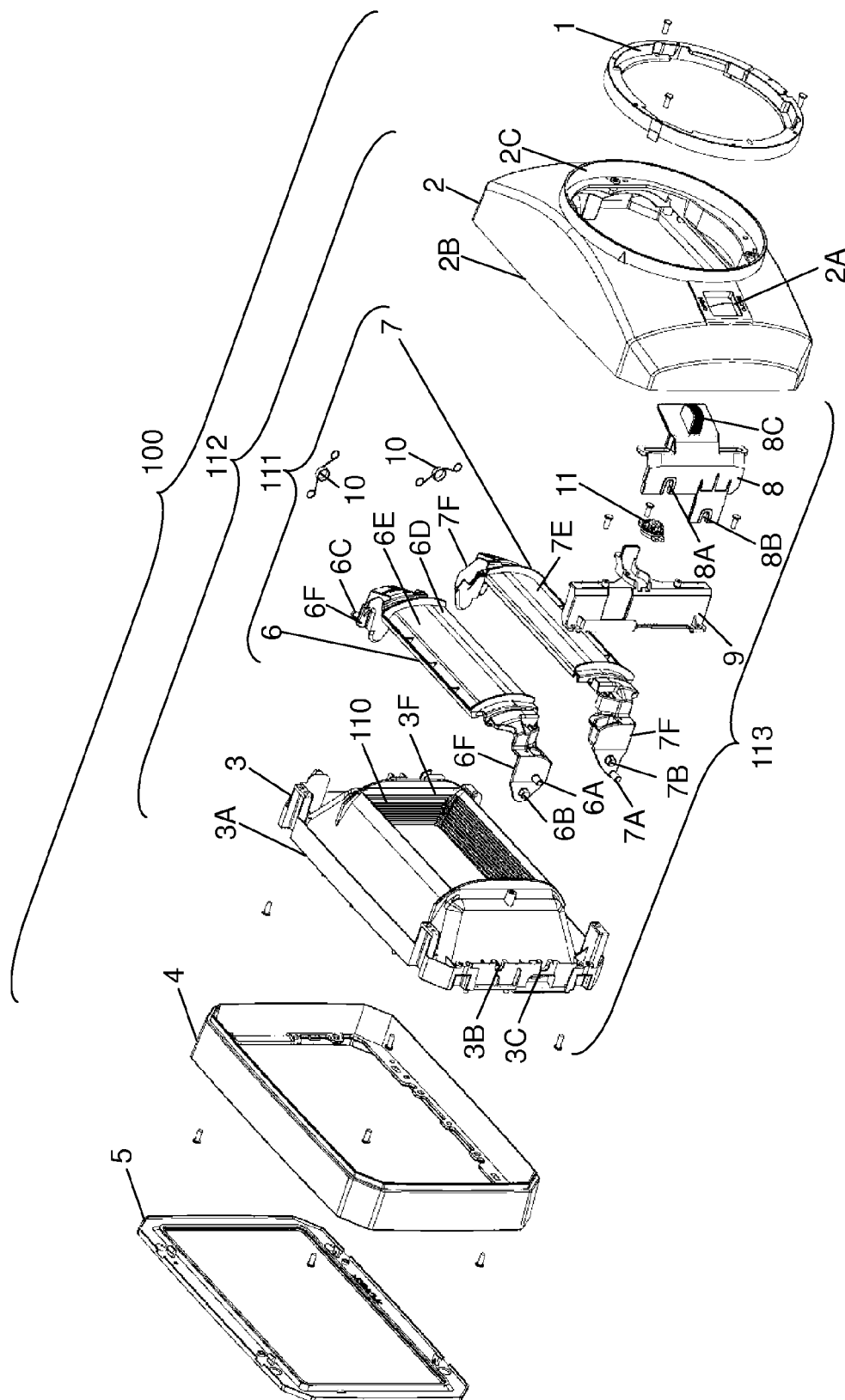


FIG. 4

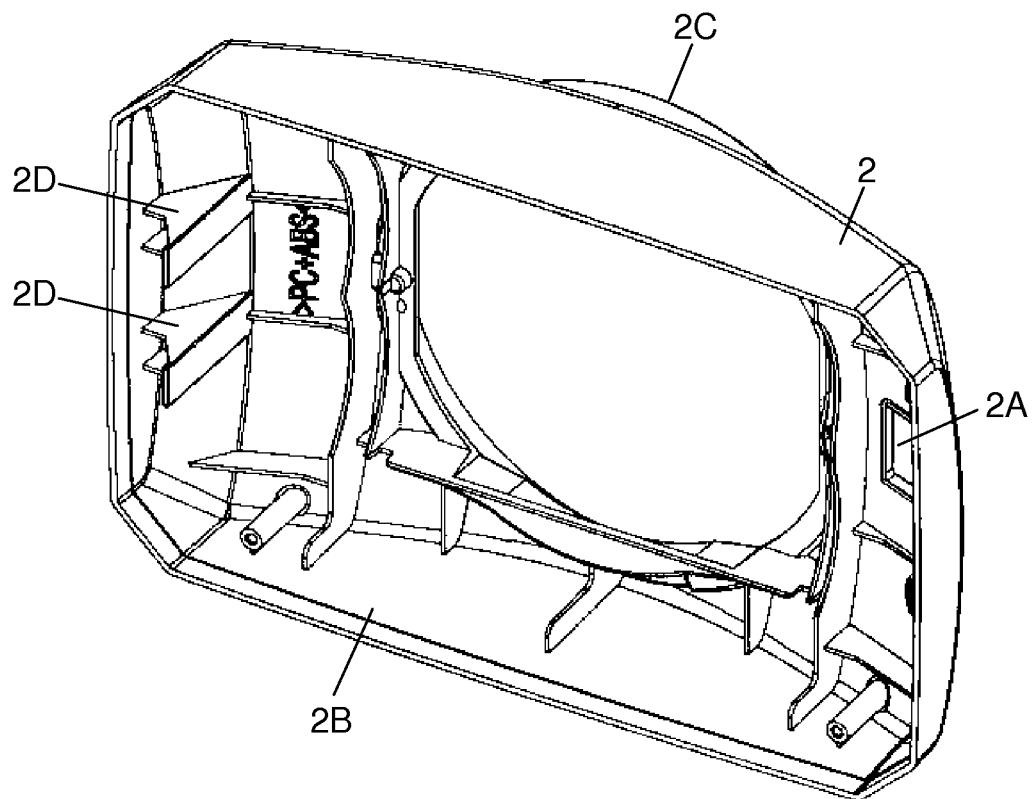


FIG. 5A

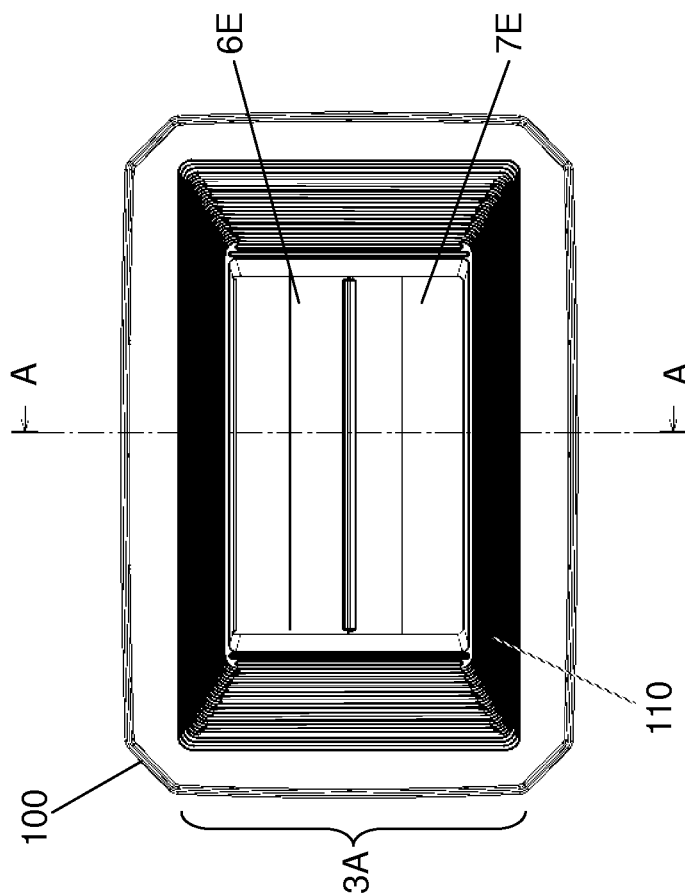


FIG. 5B

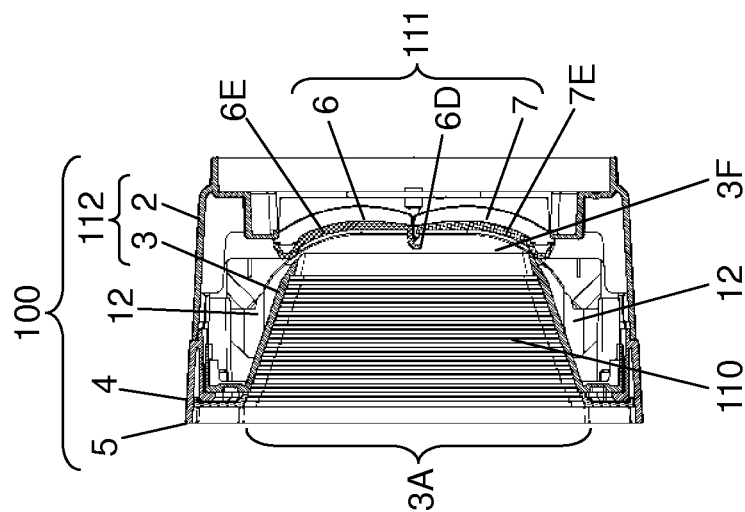




FIG. 6A

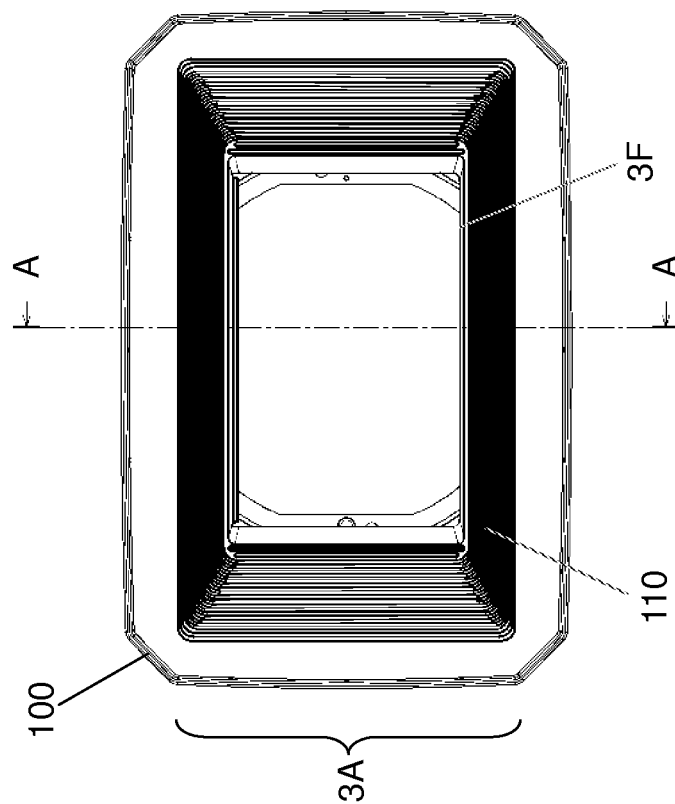


FIG. 6B

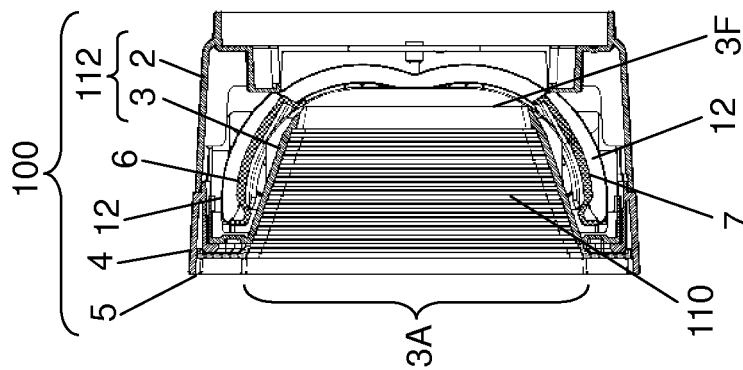


FIG. 7

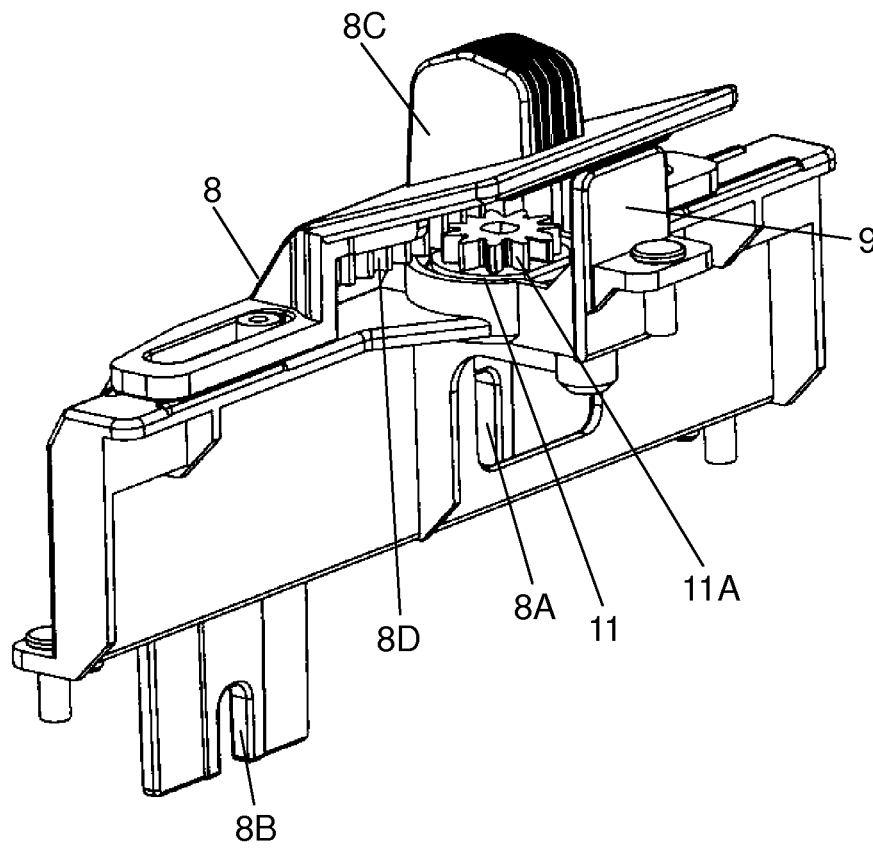


FIG. 8A

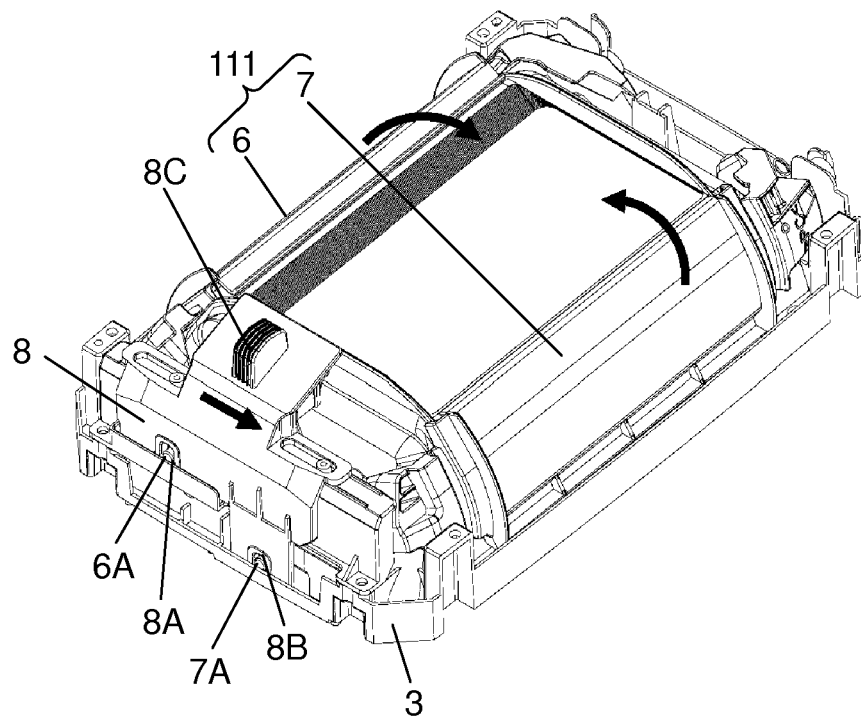


FIG. 8B

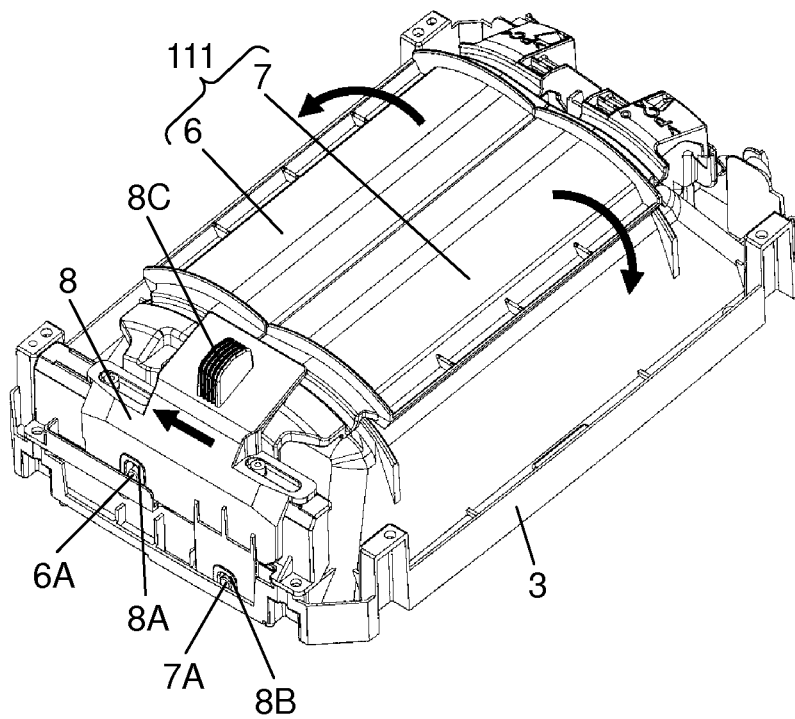


FIG. 9A

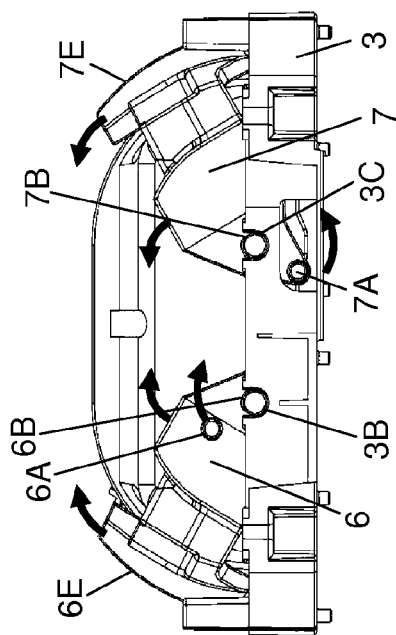


FIG. 9C

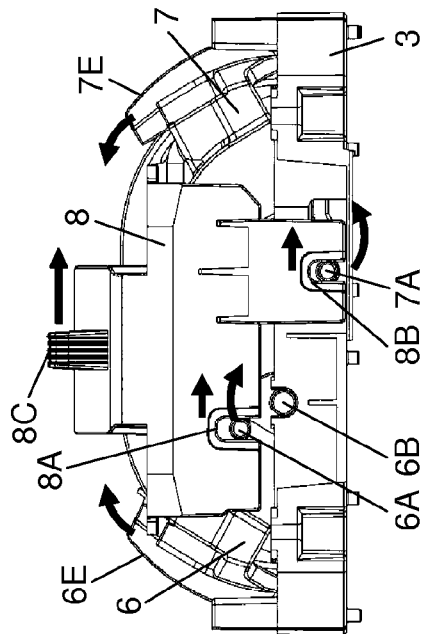


FIG. 9B

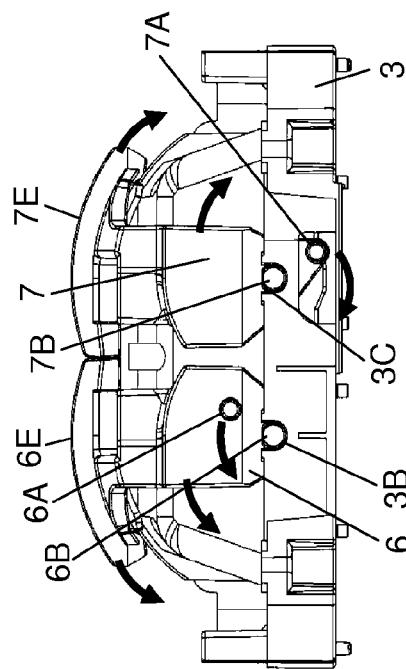


FIG. 9D

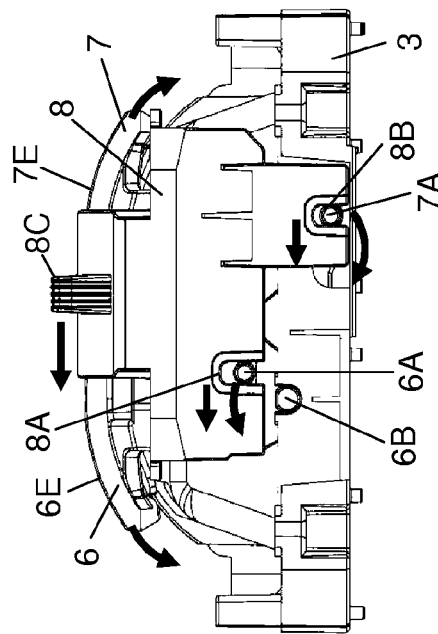
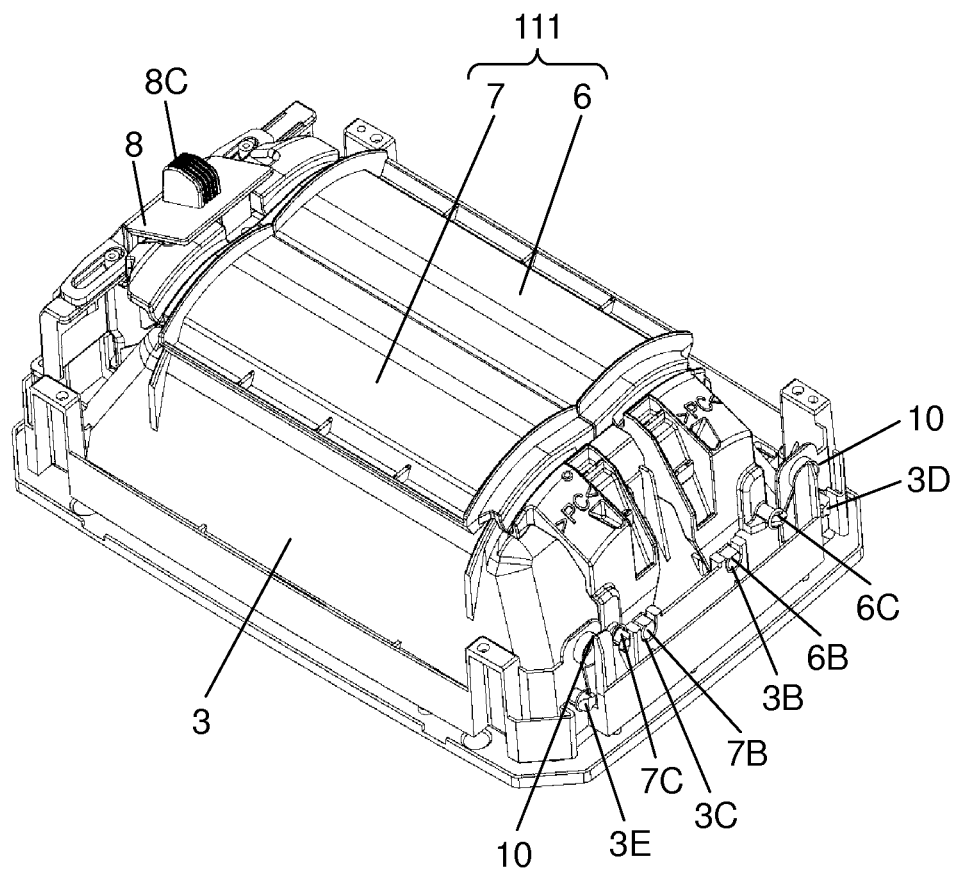


FIG. 10



## LENS HOOD AND IMAGING APPARATUS

## RELATED APPLICATIONS

This application claims the benefit of Japanese Application No. 2013-231879, filed on Nov. 8, 2013 and Japanese Application No. 2014-143819, filed on Jul. 14, 2014, the disclosures of which Applications are incorporated by reference herein.

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present disclosure relates to a lens hood attached in front of a lens to prevent undesired light incident on the lens, and an imaging apparatus to which the lens hood is attached.

## 2. Background Art

With a known structure, a lens hood and a lens cover (lens cap) are separate members that are to be attached to an imaging apparatus. However, such structure that the lens cover and the lens hood are separate members often leads to loss of the lens cover.

Unexamined Japanese Patent Publication No. 2005-17523 (Patent Document 1) discloses a lens hood with lens cover in which the lens cover is integrated into the lens hood. For the lens hood with lens cover, by sliding an operational protrusion of a lens cover open/close mechanism provided on a lens hood body, an upper door and a lower door that are stored in the lens hood body can be opened or closed.

## SUMMARY OF THE INVENTION

The present disclosure provides a lens hood integrated with a lens cover, and an imaging apparatus to which the lens hood is attached.

A lens hood of the present disclosure is attached in front of an imaging lens, and is configured to prevent undesired light incident on the imaging lens. The lens hood includes a lens cover having an upper door and a lower door, and a hood body. The hood body supports the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, and has a storage space that stores the upper door and the lower door.

An imaging apparatus of the present disclosure includes an imaging main body, an imaging lens attached to the imaging main body, a lens hood. The lens hood is attached in front of the imaging lens, and is configured to prevent undesired light incident on the imaging lens. The lens hood includes a lens cover having an upper door and a lower door, and a hood body. The hood body supports the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, and has a storage space configured to store the upper door and the lower door.

The lens hood of present disclosure is effective for increasing the dustproof effect against sands and dusts.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. 1A is a perspective view of an imaging apparatus to which a lens hood is attached in a first exemplary embodiment when viewed from the forward upper left;

FIG. 1B is a perspective view of the imaging apparatus to which the lens hood is attached in the first exemplary embodiment when viewed from the rearward upper left;

FIG. 1C is a perspective view of the imaging apparatus to which the lens hood is attached in the first exemplary embodiment when viewed from the forward upper right;

FIG. 2A is a perspective view of the lens hood in the first exemplary embodiment when viewed from the forward upper left;

FIG. 2B is a perspective view of the lens hood in the first exemplary embodiment when viewed from the rearward upper left;

FIG. 3 is an exploded view of the lens hood in the first exemplary embodiment;

FIG. 4 is a perspective view of the hood in the first exemplary embodiment when viewed from the forward upper left;

FIG. 5A is a front view of the lens hood in the state where a lens cover is closed in the first exemplary embodiment; FIG. 5B is a sectional view taken along an A-A line in FIG. 5A;

FIG. 6A is a front view of the lens hood in the state where the lens cover is opened in the first exemplary embodiment;

FIG. 6B is a sectional view taken along an A-A line in FIG. 6A;

FIG. 7 is a perspective view of a rack in the first exemplary embodiment;

FIG. 8A is a perspective view showing the state where the lens cover attached to a hood base is opened in the first exemplary embodiment;

FIG. 8B is a perspective view showing the state where the lens cover attached to the hood base is closed in the first exemplary embodiment;

FIG. 9A is a side view showing the state where the lens cover attached to the hood base is opened in the first exemplary embodiment;

FIG. 9B is a side view showing the state where the lens cover attached to the hood base is closed in the first exemplary embodiment;

FIG. 9C is a side view showing the state where the lens cover attached to the hood base is opened by a rack sliding operation;

FIG. 9D is a side view showing the state where the lens cover attached to the hood base is closed by a rack sliding operation; and

FIG. 10 is a perspective view showing the state where the lens cover attached to the hood base is closed in the first exemplary embodiment.

## DETAILED DESCRIPTION OF THE INVENTION

Exemplary embodiment will be described below in detail with reference to figures. However, more detailed description than required may be omitted. For example, detailed description of well-known matters and overlapping description of the substantially same structures may be omitted. This prevents redundant description to facilitate understanding of those skilled in the art.

Appended figures and the following description serve to help those skilled in the art to fully understand the present disclosure, and are not intended to limit the subject matter recited in claims.

## First Exemplary Embodiment

With reference to FIG. 1 to FIG. 10, a first exemplary embodiment will be described. In the first exemplary embodiment, a business-grade video camera is used as an example of imaging apparatus 200. However, imaging apparatus 200 of the present disclosure is not limited to the business-grade video camera, and may be any imaging apparatus to which

lens hood **100** can be attached, such as freeze-frame imaging apparatus and consumer video cameras.

#### [1-1. Configuration]

With reference to FIG. 1A to 1C, the configuration of imaging apparatus **200** will be generally described below.

FIG. 1A is a perspective view of imaging apparatus **200** to which lens hood **100** is attached in the first exemplary embodiment when viewed from the forward upper left. FIG. 1B is a perspective view of imaging apparatus **200** to which lens hood **100** is attached in the first exemplary embodiment when viewed from the rearward upper left. FIG. 1C is a perspective view of imaging apparatus **200** to which lens hood **100** is attached in the first exemplary embodiment when viewed from the forward upper right.

In this exemplary embodiment, in imaging apparatus **200** and each component attached to imaging apparatus **200**, a side on which imaging lens **202** is disposed is defined as a front side, a side on which view finder **203** is disposed is defined as a rear side, a direction in which imaging apparatus **200** takes an image is defined as forward, and a direction in which video is displayed on view finder **203** is defined as rearward.

As shown in FIG. 1A to 1C, imaging apparatus **200** includes imaging main body **201** substantially shaped like a rectangular parallelepiped. Imaging main body **201** is provided with a camera unit for taking a video image of a subject, a display unit for displaying the taken video image, microphone **209** for recording a sound, a record/reproduction unit for recording/reproducing an image signal output from the camera unit and a sound signal output from microphone **209**, and switch group **206** including operational buttons for various operations. These units are common component of the video camera and thus, description thereof with reference numerals is omitted.

Imaging main body **201** includes imaging lens **202** at its front face. Imaging lens **202** may be configured to be detachable from imaging main body **201**, or may be configured to be integrated with imaging main body **201**. Operational ring **210** is provided around imaging lens **202**. Operational ring **210** is configured to be able to rotate in a rotational direction about an optical axis of imaging lens **202**, and is used when the user adjusts focus, zoom, iris, and so on of a video image.

Lens hood **100** is detachably attached to a front face of imaging lens **202**. Lens hood **100** includes lens cover **111** having upper door **6** and lower door **7**. A surface of inner wall **110** of lens hood **100** takes a shape having a dustproof effect. Details of lens hood **100** will be described later.

View finder **203** for displaying a taken video image and a reproduced video image is provided rearward of imaging main body **201**. The user can view the taken video image and the reproduced video image displayed on view finder **203** to visually check the video image.

Grip part **207** with a grip belt for the user to grip imaging apparatus **200** is provided on one side face (for example, a right side face of imaging main body **201** when viewed from the front) of imaging main body **201**. Handle **204** serves as a handle for the user to use or carry imaging apparatus **200** is provided on a top of imaging main body **201**. Display **205** for displaying a taken video image and a reproduced video image is openably attached in front of handle **204**. Display **205** has a liquid crystal panel (not shown). When closed, the liquid crystal panel is stored in and hidden by a panel storage part (not shown) provided in front of handle **204**, and when opened, the liquid crystal panel rises from the panel storage part and becomes exposed. The exposed liquid crystal panel can display the video image taken through imaging lens **202** and the reproduced video image of the video signal recorded

in the record/reproduction unit thereon. A bottom face imaging main body **201** is fixed to the tripod, or can take a moving image with grip part **207** or handle **204** by hand. Thus, switch group **206** is disposed on an opposite side face of imaging main body **201** (for example, left side face of imaging main body **201** when viewed from the front) to the side face where grip part **207** is disposed, such that the user can operate imaging apparatus **200** with an opposite hand (for example, left hand) to a gripping hand (for example, right hand). Below-mentioned operational part **8C** is preferably disposed such that the user can operate operational part **8C** with a hand that operates switch group **206** (for example, left hand).

Next, with reference to FIG. 2A to FIG. 7, lens hood **100** in this exemplary embodiment will be described.

FIG. 2A is a perspective view of lens hood **100** in first exemplary embodiment when viewed from the forward upper left. FIG. 2B is a perspective view of lens hood **100** in first exemplary embodiment when viewed from the rearward upper left.

FIG. 3 is an exploded view of lens hood **100** in the first exemplary embodiment. FIG. 3 is an exploded perspective view showing exploded lens hood **100** in FIGS. 2A and 2B and each component of lens hood **100** when viewed from the rearward upper left.

FIG. 4 is a perspective view of hood **2** in the first exemplary embodiment when viewed from the forward upper left. The perspective view of FIG. 4 shows an internal structure of hood **2**.

FIG. 5A is a front view showing lens hood **100** in the state where lens cover **111** is closed in the first exemplary embodiment. FIG. 5B is a sectional view taken along an A-A line in FIG. 5A. The front view of FIG. 5A and the sectional view of FIG. 5B show arrangement of upper door **6** and lower door **7** in the state where each of upper door **6** and lower door **7** is moved from storage space **12** and is disposed between opening **3F** and a front lens element of imaging lens **202** to cover the front of imaging lens **202**, thereby allowing lens cover **111** to optically and physically shield the front of imaging lens **202**.

FIG. 6A is a front view showing lens hood **100** in the state where lens cover **111** is opened in the first exemplary embodiment. FIG. 6B is a sectional view taken along an A-A line in FIG. 6A. The front view of FIG. 6A and the sectional view of FIG. 6B show arrangement of upper door **6** and lower door **7** in the state where each of upper door **6** and lower door **7** is stored in storage space **12** to open the front of imaging lens **202** from lens cover **111**.

As shown in FIGS. 2A and 2B, and FIG. 3, lens hood **100** includes hood body **112** having hood **2** and hood base **3**, and lens cover **111** having a pair of upper door **6** and lower door **7**. As shown in FIG. 3, lens hood **100** includes cover open/close mechanism **113**. As shown in FIG. 1A to 1C, lens hood **100** is attached in front of imaging lens **202**, and is configured to prevent undesired light incident on imaging lens **202** during image-taking.

Although hood body **112**, lens cover **111**, and cover open/close mechanism **113** have an overlapping member as shown in FIG. 3, for convenience, reference numerals are assigned in this manner in this exemplary embodiment.

Hood body **112** is configured by combining hood **2** with hood base **3**. As shown in FIG. 5B and FIG. 6B, hood body **112** has storage space **12** that stores upper door **6** and lower door **7**.

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Lens cover **111** is configured to be able to be opened and closed. Specifically, upper door **6** and lower door **7** forming a pair are attached to hood base **3** so as to rotate in opposite directions to each other about an axis orthogonal to an optical axis of imaging lens **202** to constitute lens cover **111**.

Cover open/close mechanism **113** functions to move upper door **6** and lower door **7**, which are configured to rotate in opposite directions to each other, from an opened position to a closed position, or the closed position to the opened position. Hereinafter, the user's operation of moving the doors is also referred to as "opening/closing operation". The "closed position" as shown in FIGS. **5A** and **5B** refers to the arrangement of upper door **6** and lower door **7** in the state where upper door **6** and lower door **7** shield the front of imaging lens **202**. The "opened position" as shown in FIGS. **6A** and **6B** refers to the arrangement of upper door **6** and lower door **7** in the state where upper door **6** and lower door **7** are stored in storage space **12**. Details of the opening/closing operation will be described later.

Cover open/close mechanism **113** of lens hood **100** enables movement of upper door **6** and lower door **7** between the opened position and the closed position, that is, can open and close the doors.

When lens cover **111** is located at the closed position, as shown in FIGS. **5A** and **5B**, upper door **6** and lower door **7** shield an opening rearward of lens hood **100**. As a result, in imaging apparatus **200** to which lens hood **100** is attached, the front of imaging lens **202** is covered with lens cover **111** such that a front lens element (foremost lens) of imaging lens **202** is optically and physically shielded with lens cover **111**. That is, outside light emitted through opening **3A** of lens hood **100** is shielded with lens cover **111**, and sands and dusts are also shielded with lens cover **111**. Therefore, since emission of outside light into imaging lens **202** and adhesion of sands and dusts to the front lens element can be prevented, imaging apparatus **200** can be carried and kept while protecting imaging lens **202** against sands and dusts, outside light.

When lens cover **111** is located at the opened position, as shown in FIG. **6B**, upper door **6** and lower door **7** are stored in storage space **12**. Accordingly, as shown in FIG. **6A**, lens cover **111** is invisible from the front of lens hood **100**, and outside light emitted through opening **3A** of lens hood **100** passes rearward of lens hood **100** without being shielded with lens cover **111**. That is, in imaging apparatus **200** to which lens hood **100** is attached, lens cover **111** is opened, thereby optically and physically opening the front of imaging lens **202** to bring outside light into imaging lens **202** and allow imaging apparatus **200** to prepare image-taking.

Hereinafter, movement of upper door **6** and lower door **7** from the closed position to the opened position is also referred to "open the doors", and movement of upper door **6** and lower door **7** from the opened position to the closed position is also referred to "close the doors".

Cover open/close mechanism **113** is configured to include hood base **3**, upper door **6**, lower door **7**, rack **8**, rack guide **9**, pair of toggle springs **10**, and torque damper **11**. By using cover open/close mechanism **113** provided in lens hood **100**, the user can slide operational part **8C** of rack **8**, which is slidably attached to hood base **3**, and upper door **6** and lower door **7** can be rotated in opposite directions to each other by the sliding operation. That is, by the sliding operation of operational part **8C**, the user can move upper door **6** and lower door **7** between the opened position and the closed position, and can perform the opening and closing operation of lens cover **111**. Details of the mechanism will be described later.

Hood base **3** includes rectangular opening **3A** in its front portion and rectangular smaller opening **3F** than opening **3A**

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in its rear portion. Opening **3A** is connected to opening **3F** through inner wall **110**, and inner wall **110** is gradually extended from opening **3F** toward opening **3A** while keeping its rectangular shape.

A surface of inner wall **110** is formed to have a dustproof effect. In this exemplary embodiment, to obtain the dustproof effect, the surface of inner wall **110** is formed of stepped pattern from opening **3F** toward opening **3A**. Such steps prevent sands and dusts adhered to the surface of inner wall **110** from moving from opening **3A** toward opening **3F**, that is, from opening **3A** toward imaging lens **202**. Therefore, inner wall **110** in this exemplary embodiment has a higher dustproof effect than a smooth inner wall having no step.

Hood rubber **4** is attached to a front face of hood base **3**, and hood rubber **4** is formed by molding a buffer material into a rectangle shape corresponding to opening **3A** mainly to absorb shock. Front panel **5** is attached to a front face of hood rubber **4**. Hood rubber **4** is made of an elastic material having a high shock-absorbing effect, for example, elastomer, but may be other elastic materials.

A mechanism for supporting upper door **6** and lower door **7** in hood base **3** will be described later.

As shown in FIG. **4**, hood **2** has rectangular opening **2B** corresponding to opening **3A** of hood base **3** for attachment of hood **2** to hood base **3**, circular opening **2C** for attachment of hood **2** to imaging lens **202**, slide hole **2A** for protruding operational part **8C** of rack **8** stored in hood **2** to the outside, and a pair of inner walls **2D**. Slide hole **2A** is dimensioned such that operational part **8C** can be protruded from slide hole **2A** and slid by the user. Hood **2** is shaped like a substantially rectangular box so as to ensure a space for storing upper door **6** and lower door **7** when hood **2** is attached to hood base **3**, that is, to ensure a space shown as storage space **12** in FIG. **5B**. Thereby, hood **2** can be attached to hood base **3** so as to cover hood base **3** from the rear of hood base **3** while forming storage space **12** between hood base **3** and hood **2**. Inner walls **2D** will be described later.

As shown in FIG. **3**, bayonet **1** for enabling attachment/detachment to/from imaging lens **202** is attached to opening **2C** of hood **2**.

Bayonet **1** is formed to conform to the shape of imaging lens **202**. Bayonet **1** has claws for coupling to imaging lens **202** at three positions on its circumference, and can rotate with respect to imaging lens **202**, thereby being attached to and detached from imaging lens **202**. Bayonet **1** is made of an elastic material such as elastomer, and elastically engages with bayonet (not shown) of imaging lens **202**.

As shown in FIG. **3**, upper door **6** includes shield **6E** and a pair of bottom ends **6F** provided on both ends of shield **6E**. Boss-like upper-door rotational shafts **6B** protruding orthogonal to an optical axis of imaging lens **202** are formed at respective bottom ends **6F**, and upper door **6** rotates about a line connecting the pair of upper-door rotational shafts **6B** to each other as a rotational shaft. Boss-like upper-door driving cam pin **6A** protruding like upper-door rotational shaft **6B** in the vicinity of upper-door rotational shaft **6B** is formed at one bottom ends **6F** (on the side where rack **8** is attached). Boss **6C** protruding like upper-door rotational shaft **6B** in the vicinity of upper-door rotational shaft **6B** is formed at the other bottom end **6F**.

As shown in FIGS. **5A** and **5B**, shield **6E** is dimensioned to shield an upper half of opening **3F** of hood base **3**, and is shaped like an arc to be concave with respect to the rotational shaft. Accordingly, when upper door **6** is located at the closed position, an upper half of opening **3F** of hood base **3** is shielded with upper door **6**. This also shields an upper half of opening **2B** of hood **2** and in turn, optically and physically



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shields an upper half of the front lens element of imaging lens 202. When upper door 6 is located at the opened position, as shown in FIGS. 6A and 6B, the upper half of opening 3F of hood base 3 is opened to open the upper half of opening 2B of hood 2. This causes outside light emitted through opening 3A of hood base 3 to be incident on the front lens element of imaging lens 202.

A front end of shield 6E is provided with stepped overlap part 6D that overlaps a front end of shield 7E of lower door 7 located at the closed position when upper door 6 is located at the closed position. This serves to improve the shielding effect of lens cover 111 when the doors of lens cover 111 are closed, thereby preventing light and dusts from leaking rearward from the contact place between shield 6E of upper door 6 and shield 7E of lower door 7.

As shown in FIG. 3, lower door 7 includes shield 7E and a pair of bottom ends 7F provided at both ends of shield 7E. Boss-like lower-door rotational shafts 7B protruding orthogonal to the optical axis of imaging lens 202 are formed at respective bottom ends 7F, and lower door 7 rotates about a line connecting pair of lower-door rotational shafts 7B to each other as a rotational shaft. Boss-like lower-door driving cam pin 7A protruding like lower-door rotational shaft 7B in the vicinity of lower-door rotational shaft 7B is formed at one bottom end 7F (on the side where rack 8 is attached). A boss (not shown in FIG. 3) protruding like lower-door rotational shaft 7B in the vicinity of lower-door rotational shaft 7B is formed at the other bottom end 7F. This boss is shown as boss 7C in FIG. 10.

As shown in FIGS. 5A and 5B, shield 7E is dimensioned to shield a lower half of opening 3F of hood base 3, and is shaped like an arc to be concave with respect to the rotational shaft. Accordingly, when lower door 7 is located at the closed position, the lower half of opening 3F of hood base 3 is shielded with lower door 7. This shields a lower half of opening 2B of hood 2, thereby optically and physically shielding a lower half of the front lens element of imaging lens 202. When lower door 7 is located at the opened position, as shown in FIGS. 6A and 6B, the lower half of opening 3F of the hood base 3 is opened to open the lower half of the opening 2B of hood 2. This causes outside light emitted through opening 3A of hood base 3 to be incident on the front lens element of imaging lens 202.

Desirably, upper door 6 and lower door 7 are made of a material that can shield at least visible light, has a sufficient strength against external shock, and is easily molded. Examples of the material include a black-colored synthetic resin, and metal such as aluminum.

As shown in FIG. 3, hood base 3 includes a pair of shaft grooves 3B rotatably supporting pair of upper-door rotational shafts 6B and pair of shaft grooves 3C rotatably supporting pair of lower-door rotational shafts 7B on right and left side faces (both longitudinal side faces). Pair of shaft grooves 3B engage with pair of upper-door rotational shafts 6B with each other, thereby supporting upper door 6 so as to be rotatable orthogonal to the optical axis of imaging lens 202. Similarly, pair of shaft grooves 3C engage with pair of lower-door rotational shafts 7B with each other, thereby supporting lower door 7 so as to be rotatable orthogonal to the optical axis of imaging lens part 202.

Hood base 3 has protrusions 3D and 3E (not shown in FIG. 3) for supporting toggle springs 10 on an opposite side face to the side where rack 8 is attached (hidden side face in FIG. 3). Protrusions 3D and 3E will be described later with reference to FIG. 10.

When hood base 3 is integrated with hood 2, back faces of upper-door rotational shafts 6B engaged with shaft grooves

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3B and back faces of lower-door rotational shafts 7B engaged with shaft grooves 3C are supported by rack guide 9 and pair of inner walls 2D provided on hood 2 in FIG. 4. Therefore, upper-door rotational shafts 6B of upper door 6 and lower-door rotational shafts 7B of lower door 7 can be stably rotated.

Cover open/close mechanism 113 is configured to include rack 8, rack guide 9, torque damper 11, and pair of toggle springs 10 in hood body 112 formed by integrating hood base 3 with hood 2.

Rack guide 9 functions to move rack 8 in parallel when the user slides operational part 8C. Pair of toggle springs 10 functions to generate a force to bias each of upper door 6 and lower door 7 in the rotational direction. Torque damper 11 includes a gear having a resistance force to rotational motion (hereinafter referred to as "rotational resistance"). This gear is shown as gear 11A in FIG. 7.

The functioning of torque damper 11 at the time when the user slides rack 8 will be described with reference to FIG. 7. FIG. 7 is a perspective view of rack 8 in the first exemplary embodiment.

Rack 8 includes upper-door driving cam groove 8A, lower-door driving cam groove 8B, operational part 8C, and rack gear 8D.

Operational part 8C functions to help the user to perform the sliding operation in the opening/closing operation of lens cover 111, has a protruded shape, and is dimensioned so as to be easily slid with a finger of the user, and appropriately protrude from slide hole 2A. A surface of operational part 8C is slip-proof to prevent the user's finger from slipping thereon in the sliding operation.

As shown in FIG. 7, rack gear 8D is formed in the vicinity of operational part 8C in rack 8. Torque damper 11 includes gear 11A that has a rotational resistance and engages with rack gear 8D. Torque damper 11 is attached to rack 8 such that rack gear 8D engages with gear 11A. Accordingly, the rotational resistance of gear 11A of torque damper 11 is transmitted to rack 8 through rack gear 8D. Thus, rack 8 has a resistance force to parallel movement, and it can be prevented that rack 8 moves in parallel too rapidly when the user slides operational part 8C. In addition, for example, it can be prevented that upper door 6 hits against lower door 7 with too much momentum when the user open/close lens cover 111, thereby generating a large crash sound.

Next, the opening/closing operation of lens cover 111 of lens hood 100 thus configured will be described.

#### [1-2. Opening/Closing Operation of Lens Cover]

A mechanism for converting parallel movement of rack 8 into rotation of upper door 6 and lower door 7 will be described with reference to FIG. 8A to FIG. 9D. FIG. 8A to FIG. 9D are views illustrating the operation of each mechanism in opening/closing of lens cover 111. For convenience, the operational direction of each member is represented by a thick arrow in FIG. 8A to FIG. 9D.

FIG. 8A is a perspective view showing the state where lens cover 111 attached to hood base 3 is opened in the first exemplary embodiment. FIG. 8B is a perspective view showing the state where lens cover 111 attached to hood base 3 is closed in the first exemplary embodiment.

FIG. 9A is a side view showing the state where lens cover 111 attached to hood base 3 is opened in the first exemplary embodiment. FIG. 9B is a side view showing the state where lens cover 111 attached to hood base 3 is closed in the first exemplary embodiment. FIG. 9C is a side view showing the state where lens cover 111 attached to hood base 3 is opened by a sliding operation of rack 8 in the first exemplary embodiment. FIG. 9D is a side view showing the state where lens

cover 111 attached to hood base 3 is closed by a sliding operation of rack 8 in the first exemplary embodiment.

FIGS. 9A and 9B illustrate the operation of each member without showing rack 8, and FIGS. 9C and 9D show rack 8 and the operation of each member. In FIG. 9A to 9D, a left side corresponds to an upper side of lens hood 100, and a right side corresponds to a lower side of lens hood 100.

As shown in FIGS. 9A and 9B, in lens hood 100, pair of upper-door rotational shafts 6B provided on upper door 6 is axially supported by pair of shaft grooves 3B provided in hood base 3. Similarly, pair of lower-door rotational shafts 7B provided on lower door 7 is axially supported by pair of shaft grooves 3C provided in hood base 3. Although FIGS. 9A and 9B show only one side face of hood base 3, as shown in below-mentioned FIG. 10, the combination of shaft grooves 3B and upper-door rotational shafts 6B, and the combination of shaft grooves 3C and lower-door rotational shafts 7B are provided on the other side face of hood base 3.

Upper door 6 rotates about pair of upper-door rotational shafts 6B axially supported by pair of shaft grooves 3B, as rotational shafts, and lower door 7 rotates about pair of lower-door rotational shafts 7B axially supported by pair of shaft grooves 3C, as rotational shafts.

In upper door 6, upper-door driving cam pin 6A is provided in the vicinity of upper-door rotational shafts 6B between shield 6E and upper-door rotational shafts 6B. Thus, shield 6E and upper-door driving cam pin 6A move in the same direction. For example, as shown in FIG. 9A, by moving upper-door driving cam pin 6A to the right in FIG. 9A, upper door 6 rotates about upper-door rotational shafts 6B as rotational shafts to the right in FIG. 9A, and shield 6E moves from the opened position to the closed position. As shown in FIG. 9B, by moving upper-door driving cam pin 6A to the left in FIG. 9B, upper door 6 rotates about upper-door rotational shafts 6B as rotational shafts to the left in FIG. 9B, and shield 6E moves from the closed position to the opened position.

In lower door 7, lower-door driving cam pin 7A is provided in the vicinity of lower-door rotational shafts 7B such that lower-door rotational shafts 7B is disposed between shield 7E and lower-door driving cam pin 7A. Thus, shield 7E and lower-door driving cam pin 7A move in opposite directions to each other. For example, as shown in FIG. 9A, by moving lower-door driving cam pin 7A to the right in FIG. 9A, lower door 7 rotates about lower-door rotational shafts 7B as rotational shafts to the left in FIG. 9A, and shield 7E moves from the opened position to the closed position. As shown in FIG. 9B, by moving lower-door driving cam pin 7A to the left in FIG. 9B, lower door 7 rotates about lower-door rotational shafts 7B as rotational shafts to the right in FIG. 9B, and shield 7E moves from the closed position to the opened position.

As shown in FIGS. 9C and 9D, rack 8 is attached to hood base 3, upper door 6, and lower door 7 such that upper-door driving cam groove 8A of rack 8 engages with upper-door driving cam pin 6A of upper door 6, and lower-door driving cam groove 8B of rack 8 engages with lower-door driving cam pin 7A of lower door 7. Accordingly, as shown in FIG. 9C, when rack 8 moves in parallel to the right in FIG. 9C, upper-door driving cam pin 6A receives a rightward force from upper-door driving cam groove 8A in FIG. 9C to move to the right. Similarly, lower-door driving cam pin 7A receives a rightward force from lower-door driving cam groove 8B in FIG. 9C to move to the right. Thereby, upper door 6 and lower door 7 rotate in opposite directions to each other, and move from the opened position to the closed position. As shown in FIG. 9D, when rack 8 moves to the left in FIG. 9D, upper-door driving cam pin 6A receives a leftward

force from upper-door driving cam groove 8A in FIG. 9D to move to the left. Similarly, lower-door driving cam pin 7A receives a leftward force from lower-door driving cam groove 8B in FIG. 9D to move to the left. Thereby, upper door 6 and lower door 7 rotate in opposite directions to each other, and move from the closed position to the opened position.

As described above, in lens hood 100 in this exemplary embodiment, relative positional relation between upper-door rotational shafts 6B and upper-door driving cam pin 6A is opposite to relative positional relation between lower-door rotational shafts 7B and lower-door driving cam pin 7A. For this reason, when the user slides operational part 8C to move rack 8 in parallel, upper door 6 and lower door 7 rotate in opposite directions to each other. That is, the user can open and close lens cover 111 by sliding operational part 8C.

The opening/closing operation of upper door 6 and lower door 7 is biased by toggle springs 10. This configuration will be described with reference to FIG. 10.

FIG. 10 is a perspective view showing the state where lens cover 111 attached to hood base 3 is closed in the first exemplary embodiment. The perspective view of FIG. 10 shows locations of toggle springs 10 that bias lens cover 111 when lens cover 111 attached to hood base 3 is opened or closed.

As shown in FIG. 10, lens hood 100 has pair of toggle springs 10. One toggle spring 10 is a component to bias upper door 6, and engages with protrusion 3D of hood base 3 and boss 6C of upper door 6. The other toggle springs 10 is a component to bias lower door 7, and engages protrusion 3E of hood base 3 and boss 7C of lower door 7.

Lens hood 100 in this exemplary embodiment includes a toggle mechanism which is configured to include pair of toggle springs 10, protrusions 3D and 3E provided on hood base 3, boss 6C of upper door 6, and boss 7C of lower door 7.

In both cases where upper door 6 and lower door 7 are moved from the opened position to the closed position and upper door 6 and lower door 7 are moved from the closed position to the opened position, toggle springs 10 generate a resistance force to the movement at start of movement in upper door 6 and lower door 7, and then, bias upper door 6 and lower door 7 in the moving direction when upper door 6 and lower door 7 pass a predetermined position (for example, a middle point between the closed position and the opened position). Therefore, upper door 6 and lower door 7 are stably disposed at the closed position or the opened position.

#### [1-3. Effect]

As described above, in this exemplary embodiment, lens hood 100 is attached in front of imaging lens 202 and is configured to prevent undesired light incident on imaging lens 202. Lens hood 100 includes lens cover 111 having upper door 6 and lower door 7 and hood body 112. Hood body 112 supports upper door 6 and lower door 7 so as to rotate upper door 6 and lower door 7 in opposite directions to each other about the axis orthogonal to the optical axis of imaging lens 202, and has storage space 12 that stores upper door 6 and lower door 7.

In lens hood 100, while lens cover 111 is closed, upper door 6 and lower door 7 can shield the front of imaging lens 202. That is, lens hood 100 has a function as the lens hood (function of preventing undesired light incident on imaging lens 202) as well as a function as the lens cap (function of optically and physically shielding the front face of imaging lens 202).

In this exemplary embodiment, imaging apparatus 200 includes imaging main body 201, imaging lens 202 attached to imaging main body 201, and lens hood 100 attached in front of imaging lens 202.

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Accordingly, by attaching lens hood **100** to imaging apparatus **200**, the necessity of exchanging lens hood with lens cap at image-taking and carrying can be eliminated, improving the convenience for the user.

In this exemplary embodiment, hood body **112** includes hood base **3** that rotatably supports upper door **6** and lower door **7**, and hood **2** attached to hood base **3** to cover hood base **3** forming storage space **12** between hood **2** and hood base **3**.

In this exemplary embodiment, upper door **6** and lower door **7** are supported by hood base **3** so as to rotate between the opened position where the doors are stored in storage space **12** and the front of imaging lens **202** is opened and the closed position where the front of imaging lens **202** is shielded.

Thus, in lens hood **100**, when lens cover **111** is opened, as shown in FIG. **6B**, upper door **6** and lower door **7** can be stored in storage space **12**.

For example, with a conventional structure in which an upper door and a lower door fall to the inner wall of lens hood to open the lens cover (for example, the above-mentioned structure disclosed in Patent Document 1), during opening of the lens cover, back faces of upper door and lower door (faces opposed to the front face of imaging lens during opening of the lens cover) are exposed and therefore, sands and dusts are easily adhered to the back faces of upper door and lower door. Accordingly, in the opening/closing operation of the lens cover, sands and dusts adhered to the back faces of the upper door and the lower door can move and adhere to the front face of the imaging lens. Such sands and dusts may soil and damage the surface of the lens.

However, in lens hood **100** in this exemplary embodiment, when lens cover **111** is opened, for example, as shown in FIG. **6B** and FIG. **8A**, upper door **6** and lower door **7** each are stored in storage space **12**. That is, in either state where lens cover **111** is located at the closed position or at the opened position, when back faces of upper door **6** and lower door **7** (faces opposed to the front face of imaging lens **202** when lens cover **111** is located at the closed position) are not exposed and therefore, sands and dusts are hard to adhere to the back faces of upper door **6** and lower door **7**. Therefore, in lens hood **100** in this exemplary embodiment, in the opening/closing operation of lens cover **111**, sands and dusts hardly adhere to the front face of imaging lens **202**, reducing the possibility that sands and dusts soil or damage the surface of imaging lens **202**.

In this exemplary embodiment, upper door **6** has pair of boss-like upper-door rotational shafts **6B**, and lower door **7** has pair of boss-like lower-door rotational shafts **7B**. Hood base **3** has pair of shaft grooves **3B** rotatably supporting pair of upper-door rotational shafts **6B** and pair of shaft grooves **3C** rotatably supporting pair of lower-door rotational shafts **7B**.

In this exemplary embodiment, lens hood **100** includes rack **8** having upper-door driving cam groove **8A** and lower-door driving cam groove **8B**. Upper-door driving cam pin **6A** is formed in the vicinity of upper-door rotational shaft **6B** of upper door **6**, and lower-door driving cam pin **7A** is formed in the vicinity of lower-door rotational shaft **7B** of lower door **7**. Rack **8** is arranged such that upper-door driving cam pin **6A** engages with upper-door driving cam groove **8A** and lower-door driving cam pin **7A** engages with lower-door driving cam groove **8B**. In lens hood **100**, through parallel movement of rack **8**, upper-door driving cam pin **6A** is moved by pressure of upper-door driving cam groove **8A**, so that upper door **6** rotates about upper-door rotational shafts **6B**, and lower-door driving cam pin **7A** is moved by pressure of lower-door

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driving cam groove **8B**, so that lower door **7** rotates about lower-door rotational shafts **7B**.

In lens hood **100** in this exemplary embodiment, relative positional relation between upper-door rotational shafts **6B** and upper-door driving cam pin **6A** is opposite to relative positional relation between lower-door rotational shafts **7B** and lower-door driving cam pin **7A**, enabling upper door **6** and lower door **7** to rotate in opposite directions to each other.

In this exemplary embodiment, rack **8** has operational part **8C** for the user to perform the sliding operation.

Thereby, the user can rotate upper door **6** and lower door **7** in opposite directions to each other, by the sliding operation of operational part **8C**. That is, the user can perform the opening and closing operation of lens cover **111** easily, by the sliding operation of operational part **8C**.

In this exemplary embodiment, hood base **3** has inner wall **110** shaped to have the dustproof effect. When located at both the opened position and closed position, upper door **6** and lower door **7** do not cover inner wall **110**, resulting in that inner wall **110** of hood base **3** is exposed at all times.

Thus, in lens hood **100**, irrespective of opening or closing of lens cover **111**, the dustproof effect of the surface of inner wall **110** can be acquired at all times.

For example, with the conventional structure in which the upper door and the lower door fall to the inner wall of lens hood to open the lens cover (for example, the above-mentioned structure disclosed in Patent Document 1), during opening of the lens cover, the upper door and the lower door cover the inner wall of the lens hood. For this reason, even when the surface of the inner wall of the lens hood has the dustproof effect, during opening of the lens cover, for example, during image-taking, the surface of the inner wall of the lens hood is covered with the upper door and the lower door, decreasing the dustproof effect.

However, in lens hood **100** in this exemplary embodiment, while the lens cover **111** is opened, for example, as shown in FIG. **6B** and FIG. **8A**, upper door **6** and lower door **7** each are stored in storage space **12**. That is, in either state where lens cover **111** is located at the closed position or at the opened position, the surface of inner wall **110** of hood base **3** is not covered with upper door **6** and lower door **7**, and remains exposed at all times. Accordingly, in lens hood **100** in this exemplary embodiment, irrespective of opening or closing of lens cover **111**, the dustproof effect of the surface of inner wall **110** can be obtained at any time. That is, even while lens cover **111** is opened to use imaging apparatus **200** for image-taking, the dustproof effect of the surface of inner wall **110** can be acquired as in the same manner in which lens cover **111** is closed.

In other words, the technique of the lens hood in this exemplary embodiment is effective for improving the dustproof effect against sands and dusts.

Further, the lens hood of the present disclosure is attached in front of the imaging lens and therefore, is especially effective for an imaging apparatus in which operational ring **210** is provided around the imaging lens, making arrangement of another member around the imaging lens difficult, for example, business-grade video camera.

## Other Exemplary Embodiments

The first exemplary embodiment has been described as an example of the technique disclosed in this application. However, the technique of the present disclosure is not limited to this, and may be applied to exemplary embodiments subjected modification, replacement, addition, and omission.

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Further, the constituents in the first exemplary embodiment may be combined with each other to create a new exemplary embodiment.

Other exemplary embodiments will be described.

Although the surface of inner wall **110** is formed of stepped pattern in the first exemplary embodiment, the surface of inner wall **110** is not limited to this, and may take any shape having the dustproof effect. For example, the surface of inner wall **110** may be embossed with semi-granular protrusions or convex lines to have irregularities.

The present disclosure can apply to a lens hood attached in front of the imaging lens, and an imaging apparatus in which the lens hood can be attached in front of the imaging lens. Specifically, the present disclosure can apply to moving imaging apparatuses such as business-grade video cameras and consumer video cameras, and still imaging apparatuses such as digital still cameras, as well as the lens hood attached to the imaging apparatuses.

What is claimed is:

**1.** A lens hood to be attached in front of an imaging lens and configured to prevent undesired light incident on the imaging lens, the lens hood comprising:

a lens cover having an upper door and a lower door; and a hood body configured to support the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, wherein:

the hood body includes a storage space configured to store the upper door and the lower door, and

when the upper door and the lower door are stored in the storage space, front faces and back faces of the upper door and the lower door are not exposed to an opening of the lens hood, the back faces being opposed to the imaging lens when lens hood is attached to the imaging lens and the upper door and the lower door are in a closed position.

**2.** The lens hood according to claim **1**, wherein the hood body includes:

a hood base configured to rotatably support the upper door and the lower door; and a hood configured to cover the hood base to form the storage space between the hood and the hood base.

**3.** The lens hood according to claim **2**, wherein:

the upper door and the lower door are supported by the hood base so as to rotate between an opened position where the doors are stored in the storage space and a front of the imaging lens is opened and the closed position where the front of the imaging lens is shielded.

**4.** The lens hood according to claim **3**, wherein:

the upper door has a pair of boss-like upper-door rotational shafts,

the lower door has a pair of boss-like lower-door rotational shafts, and

the hood base has a pair of shaft grooves rotatably supporting the pair of upper-door rotational shafts and a pair of shaft grooves rotatably supporting the pair of lower-door rotational shafts.

**5.** The lens hood according to claim **4**, further comprising a rack having an upper-door driving cam groove and a lower-door driving cam groove, wherein:

an upper-door driving cam pin is formed in the vicinity of the upper-door rotational shaft of the upper door,

a lower-door driving cam pin is formed in the vicinity of the lower-door rotational shaft of the lower door,

the rack is disposed such that the upper-door driving cam pin engages with the upper-door driving cam groove and

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the lower-door driving cam pin engages with the lower-door driving cam groove, and

through parallel movement of the rack, the upper-door driving cam pin is moved by pressure of the upper-door driving cam groove to rotate the upper door about the upper-door rotational shafts, and the lower-door driving cam pin is moved by pressure of the lower-door driving cam groove to rotate the lower door about the lower-door rotational shafts.

**6.** The lens hood according to claim **5**, wherein relative positional relation between the upper-door rotational shafts and the upper-door driving cam pin is made opposite to relative positional relation between the lower-door rotational shafts and the lower-door driving cam pin, so that the upper door and the lower door can rotate in opposite directions to each other.

**7.** The lens hood according to claim **5**, wherein the rack has an operational part for a user's sliding operation.

**8.** The lens hood according to claim **1**, wherein:

the hood base has an inner wall formed of a shape having a dustproof effect, and

in either case where the upper door and the lower door are located at an opened position or at a closed position, the upper door and the lower door do not cover the inner wall, so that the inner wall is exposed at all times.

**9.** The lens hood according to claim **8**, wherein the inner wall is formed of stepped pattern.

**10.** An imaging apparatus comprising:

an imaging main body;

an imaging lens attached to the imaging main body; and the lens hood according to claim **1** attached in front of the imaging lens and configured to prevent undesired light incident on the imaging lens.

**11.** A lens hood to be attached in front of an imaging lens and configured to prevent undesired light incident on the imaging lens, the lens hood comprising:

a lens cover having an upper door and a lower door; and a hood body configured to support the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, wherein:

the hood body includes a storage space configured to store the upper door and the lower door, the hood body includes:

a hood base configured to rotatably support the upper door and the lower door; and

a hood configured to cover the hood base to form the storage space between the hood and the hood base,

the upper door and the lower door are supported by the hood base so as to rotate between an opened position where the doors are stored in the storage space and a front of the imaging lens is opened and a closed position where the front of the imaging lens is shielded,

the upper door has a pair of boss-like upper-door rotational shafts,

the lower door has a pair of boss-like lower-door rotational shafts, and

the hood base has a pair of shaft grooves rotatably supporting the pair of upper-door rotational shafts and a pair of shaft grooves rotatably supporting the pair of lower-door rotational shafts.

**12.** The lens hood according to claim **11**, further comprising a rack having an upper-door driving cam groove and a lower-door driving cam groove, wherein:

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an upper-door driving cam pin is formed in the vicinity of the upper-door rotational shaft of the upper door, a lower-door driving cam pin is formed in the vicinity of the lower-door rotational shaft of the lower door, the rack is disposed such that the upper-door driving cam pin engages with the upper-door driving cam groove and the lower-door driving cam pin engages with the lower-door driving cam groove, and through parallel movement of the rack, the upper-door driving cam pin is moved by pressure of the upper-door driving cam groove to rotate the upper door about the upper-door rotational shafts, and the lower-door driving cam pin is moved by pressure of the lower-door driving cam groove to rotate the lower door about the lower-door rotational shafts.

**13.** The lens hood according to claim **12**, wherein relative positional relation between the upper-door rotational shafts and the upper-door driving cam pin is made opposite to relative positional relation between the lower-door rotational shafts and the lower-door driving cam pin, so that the upper door and the lower door can rotate in opposite directions to each other.

**14.** The lens hood according to claim **12**, wherein the rack has an operational part for a user's sliding operation.

**15.** A lens hood to be attached in front of an imaging lens and configured to prevent undesired light incident on the imaging lens, the lens hood comprising:  
a lens cover having an upper door and a lower door; and

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a hood body configured to support the upper door and the lower door so as to rotate the upper door and the lower door in opposite directions to each other about an axis orthogonal to an optical axis of the imaging lens, wherein:

the hood body includes a storage space configured to store the upper door and the lower door,

the hood body includes a hood base configured to rotatably support the upper door and the lower door,

the hood base has an inner wall formed of a shape having a dustproof effect, and

in either case where the upper door and the lower door are located at an opened position or at a closed position, the upper door and the lower door do not cover the inner wall, so that the inner wall is exposed at all times.

**16.** The lens hood according to claim **15**, wherein the inner wall is formed of stepped pattern.

**17.** An imaging apparatus comprising:

an imaging main body;

an imaging lens attached to the imaging main body; and

the lens hood according to claim **11** attached in front of the imaging lens and configured to prevent undesired light incident on the imaging lens.

**18.** An imaging apparatus comprising:

an imaging main body;

an imaging lens attached to the imaging main body; and

the lens hood according to claim **15** attached in front of the imaging lens and configured to prevent undesired light incident on the imaging lens.

\* \* \* \* \*